International Journal of Power Electronics and Drive System (IJPEDS)
Vol. 10, No. 4, December 2019, pp. 2096~2100
ISSN: 2088-8694, DOI: 10.11591/ijpeds.v10.i4.2096-2100

Control and supervision of a solar electric system

Benabed Khadidja[1], Boudghene Stambouli Amine[2], Benabadji Noureddine[3]
[1, 2] Département d'Electronique, Université des Sciences et de la Technologie d'Oran Mohamed Boudiaf, USTO-MB, BP 1505, El M'naouer, 31000 Oran Algérie
[3] Laboratoire d'Analyse et d'Application des Rayonnements (LAAR), Université des Sciences et de la Technologie d'Oran Mohamed Boudiaf, USTO-MB, BP 1505, El M'naouer, 31000 Oran Algérie

Article Info

Article history:

Received Jan 14, 2019
Revised Mar 1, 2019
Accepted Jul 24, 2019

Keywords:

Microcontroller
Monitor
Photovoltaic system
Solar energy
Supervision

ABSTRACT

Energy consumption is one of the biggest concerns because it is increasing and it has a great impact on our environment. Photovoltaic energy is a possible response to the challenges of the energy transition of tomorrow. For proper operation, the solar photovoltaic system needs a rigorous supervision of its electrical and physical parameters. Monitoring is one of the foundations of photovoltaic maintenance engineering. This article describes the design and realization of a solar monitor for the monitoring of the correct operation of a mini power plant from panels photovoltaic.

Corresponding Author:

Benabed Khadidja,
Département d'Electronique,
Université des Sciences et de la Technologie d'Oran Mohamed Boudiaf,
BP 1505, El M'naouer, 31000 Oran Algérie.
Email: Khadidja.benabed@univ-usto.dz

1. INTRODUCTION

Solar energy is playing major role as an important renewable energy source due to its cleanness, zero cost and everywhere availability [1]. Photovoltaic technology has advanced and made solar panels more flexible and easier to install [2].

The supervision of a photovoltaic system, or monitoring, makes it possible to evaluate the operation quality of the system and on the other hand to detect any anomalies. It is generally composed of a data acquisition and storage system, a signal processing or analysis software, and a display. The supervising system is a solution for limit production losses and improves solar plant performance [3]. Grace an alert system, fault analysis is possible to reduce the cost of maintenance and avoid unnecessary travel [4]. There are many systems for evaluating the performance of a photovoltaic system [5]-[9]. Some systems allow, for example, the comparison between the actual production of an installation and the theoretical production. An alert is sent to the user warning of an anomaly on the PV system. This article describes the design and construction of a solar monitor for the supervision and control of a PV solar system.

2. MATERIAL AND METHODS

The realized device is dedicated for 6V or 12V photovoltaic panels system at a medium power (up to 50W). It is responsible for performing automatic and periodic measurements of five important physical parameters to be monitored: the charging current of the energy accumulator (battery), the discharge current, the charging voltage, the external temperature (close to P.V.) and the internal temperature (close to battery) (Figure 1).

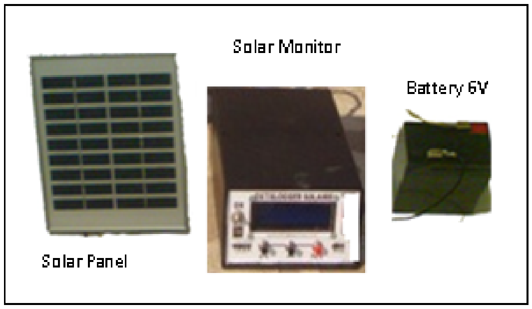

Figure 1. System overview

3. HARDWARE DESCRIPTION

The diagram in the figure 2 shows the main modules of this device: an 8-bit microcontroller (PIC18F452), a 2x16 characters LCD display module and the regulated power section.

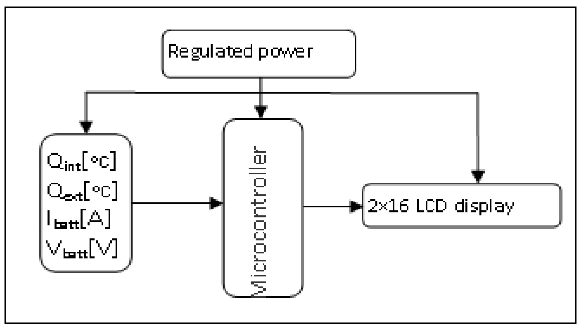

Figure 2. Block diagram of the prototype device.

3.1. The 8-bits microcontroller pic 18f452

It is a microcontroller of the high-end range of the American company Microchip, a world leader in this category of programmable digital components. It is equipped with a RISC architecture, whose performances in speed and memory usage are much better than the old CISC architecture [10]. The PIC is powered by a voltage of 5V. The resistor R0 has been added to lower the current on the MCLR pin. The diode D0 is added to prevent high voltage Vpp (13V) goes to Vdd when doing In-Circuit Programming of the microcontroller. The LED indicates the presence of power in the monitor (Figure 3). Capacitor C0 filters any transient voltage or noise that could crash the system.

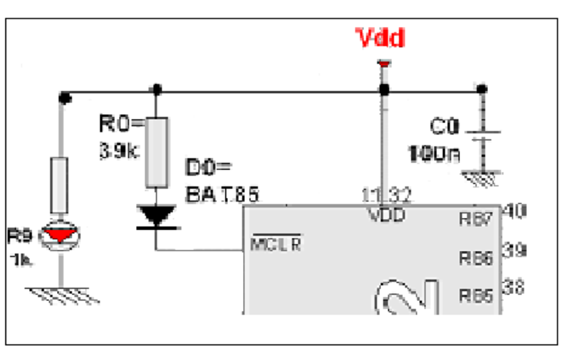

Figure 3. Electrical diagram of the PIC power supply.

3.2. The regulated power supply section

The regulator used is a classic regulator 78L05, low power version (max. output current = 100 mA). A Schottky diode BAT85 has been added to bias this 78L05 regulator, in order to slightly increase the supply voltage Vdd to +5.12V. This particular value allows us to round the measurement sensitivity precisely to 5 mV, instead of 4.88 mV if we kept Vdd = 5V, which greatly simplifies the programming subroutine of data acquisition. The two capacitors C3, C4 are placed at each side of the regulator to smooth the voltage in case of sudden transient higher consumption that could occur in long wiring when connecting P.V. panel to the microcontroller board (Figure 4).

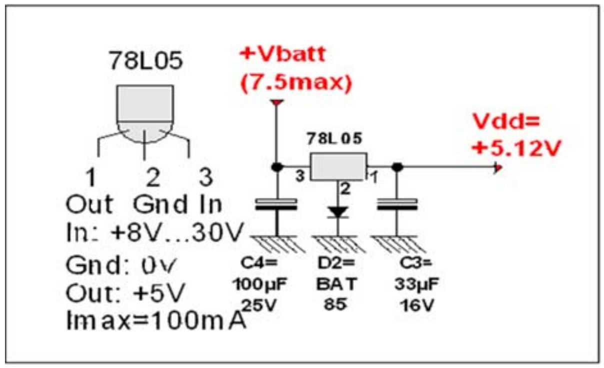

Figure 4. The Regulated power supply.

3.3. The LCD display module 2x16 characters

A 2x16 character LCD display module requires at least 10 I/O lines (Inputs / outputs) from the PIC, in 8-bit mode, or only 6 I/O lines in 4-bit mode [11]. The LCD display is powered by a voltage of 5V +/- 5%. To save the input / output ports of the PIC, the LCD module will operate in 4-bit mode (4 data bits) instead of 8 (LCD module configuration at initialization), and only in write mode (pin RW connected to the ground). The contrast control can be adjusted using the potentiometer Aj1(figure 5).

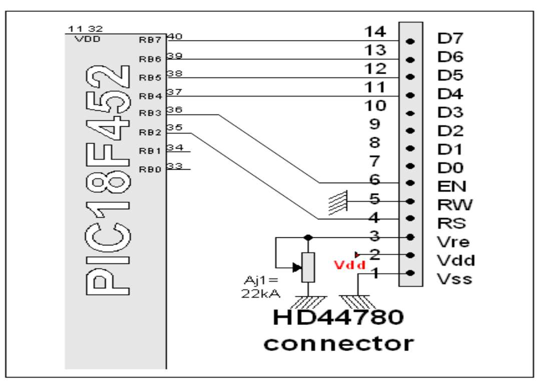

Fig. 5. The 2x16 LCD display module.

3.4. The temperature sensor supply

The temperature sensor is a LM35DZ that can measure a temperature between 0 and + 100 °C; it provides a voltage proportional to the temperature with a resolution of 10 mV / °C [12]. The LM35DZ temperature sensor can be powered in a range of 4 to 20V with an internal consumption of less than 60µA at 4V. For our internal temperature sensor, the regulated power supply Vdd has been used, while for the external one, we directly used the 6V photovoltaic panel. In the absence of the sunshine, it is powered directly by the battery. Resistor R7 and capacitor C6 (for the external temperature sensor) act as a series RC

damper to improve the tolerance of long wires capacitance (PV panel are mounted far from the microcontroller board) (Figure 6 and Figure 7).

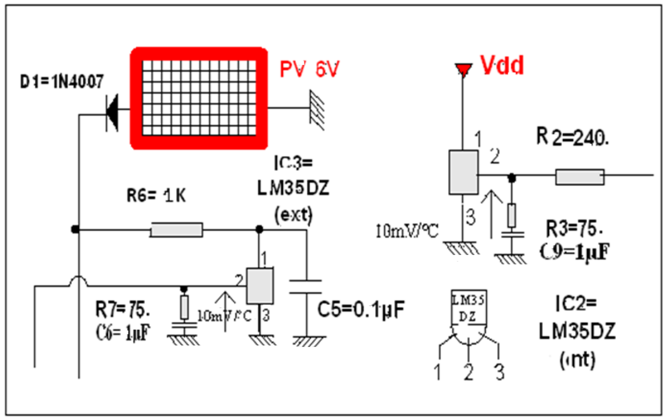

Figure 6. Diagram of the internal and external temperature sensors.

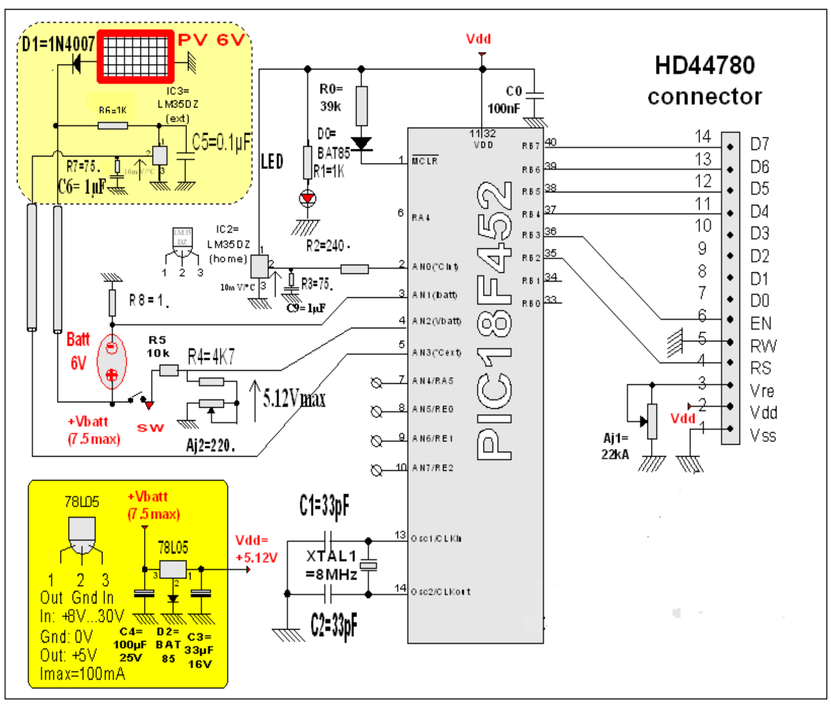

Figure 7. Complete electrical circuit diagram.

4. RESULTS AND DISCUSSIONS

This solar monitor is responsible for performing automatic and periodic measurements of important physical parameters be monitored. It offers information about internal and external temperature, the current and voltage involved between the P.V. panels system and the energy storage system (Figure 8).This device uses few components, readily available and a very low cost.

Figure 8. The display of the four measured parameters.

5. CONCLUSION

This paper describes the design and implementation of an automatic recording device (solar monitor) to measure several important physical parameters (internal and external temperature, the current and voltage involved between the P.V. panels system and the energy storage system). This prototype uses few components, readily available and provides a good reliability. It is recommended in the management and the monitoring of a low cost operational solar power plant based on photovoltaic panels.

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